

Exhibit C



US011906794B2

(12) **United States Patent**
Higley et al.

(10) **Patent No.: US 11,906,794 B2**
(45) **Date of Patent: Feb. 20, 2024**

(54) **FLEXIBLE PUSH-PULL BOOT AND CRIMP BODY FOR FIBER OPTIC CONNECTOR**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/351,399**

(22) Filed: **Jul. 12, 2023**

(65) **Prior Publication Data**

US 2023/0358973 A1 Nov. 9, 2023

Related U.S. Application Data

(62) Division of application No. 17/045,068, filed as application No. PCT/US2019/025944 on Apr. 5, 2019, now Pat. No. 11,719,893.

(60) Provisional application No. 62/793,198, filed on Jan. 16, 2019, provisional application No. 62/653,706, filed on Apr. 6, 2018.

(51) **Int. Cl.**
G02B 6/36 (2006.01)
G02B 6/38 (2006.01)

(52) **U.S. Cl.**
CPC **G02B 6/3888** (2021.05); **G02B 6/3825** (2013.01); **G02B 6/3893** (2013.01); **G02B 6/38875** (2021.05)

(58) **Field of Classification Search**
CPC G02B 6/3888; G02B 6/3825; G02B 6/38875; G02B 6/3893; G02B 6/36
See application file for complete search history.

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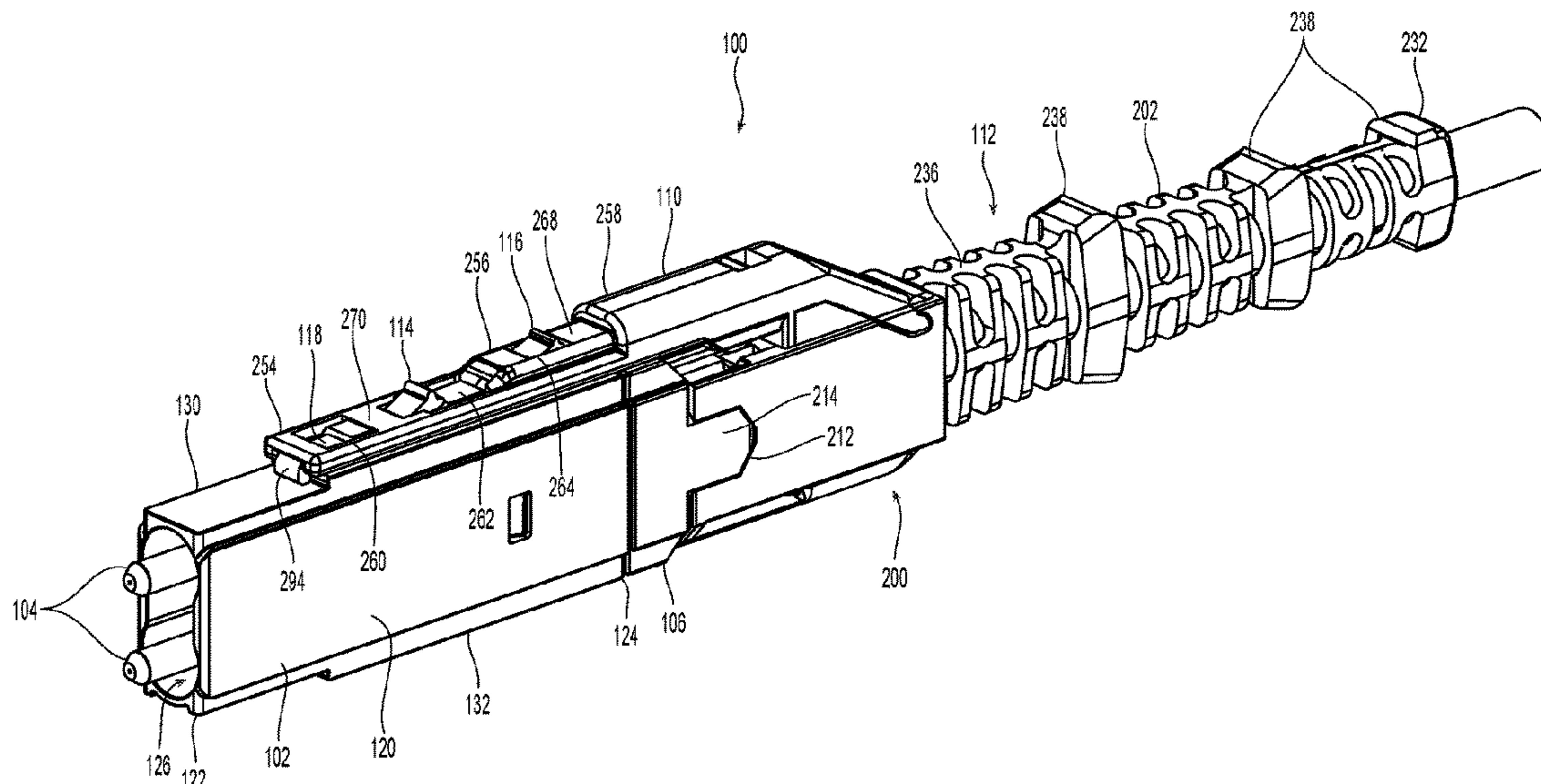
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(57) **ABSTRACT**

A new boot for a fiber optic connector has a ribbed back portion, a center portion, and a forward extending portion that can be used to insert and remove the fiber optic connector to receptacle. The ribbed back portion has grasping elements and is connected to the center portion. The center portion is removably connected to a crimp body that is in turn connected to the connector housing. The front extension is connected to the fiber optic connector and also provides a keying feature depending on the side of the fiber optic connector on which it is installed.

20 Claims, 15 Drawing Sheets



US 11,906,794 B2

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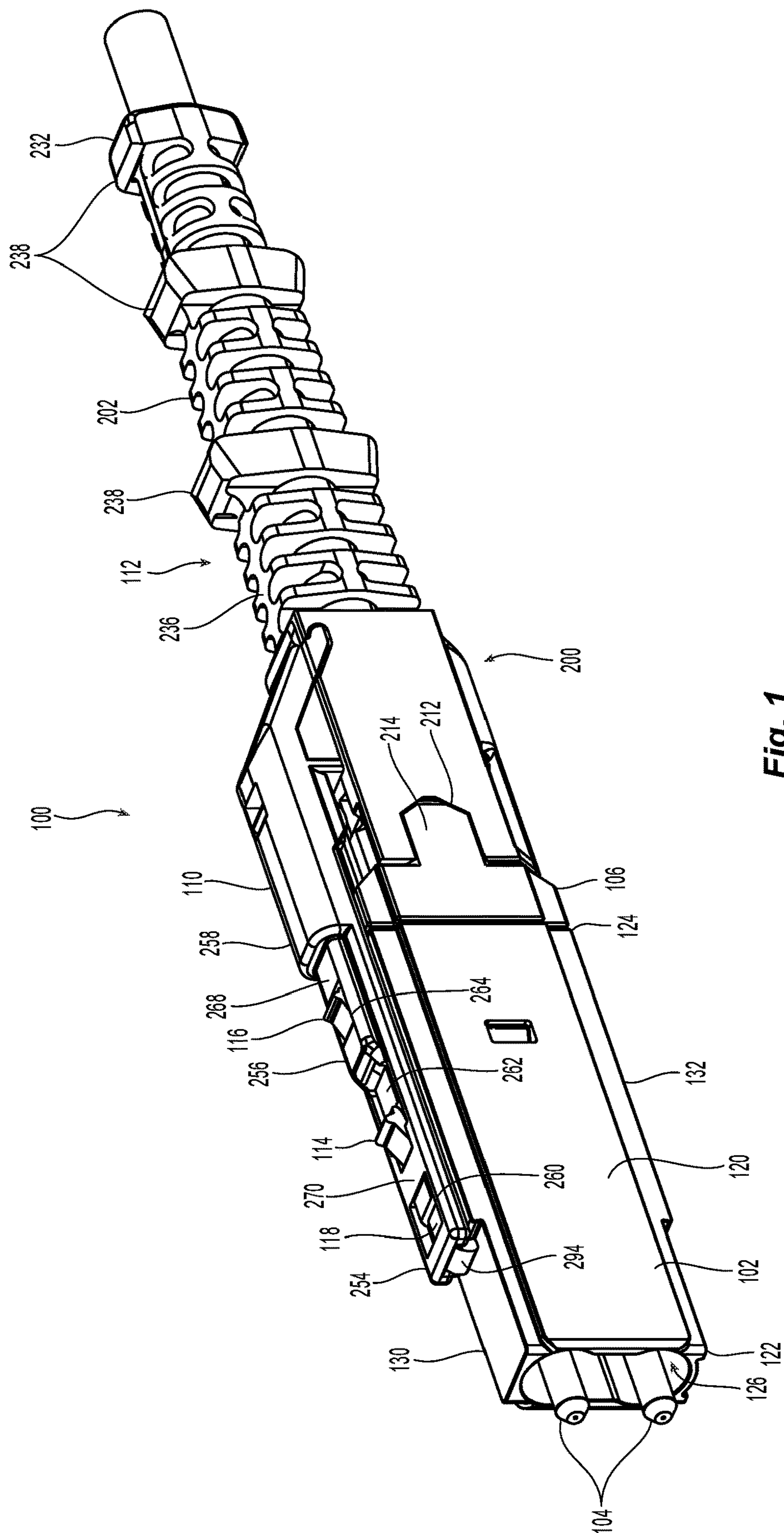


Fig. 1

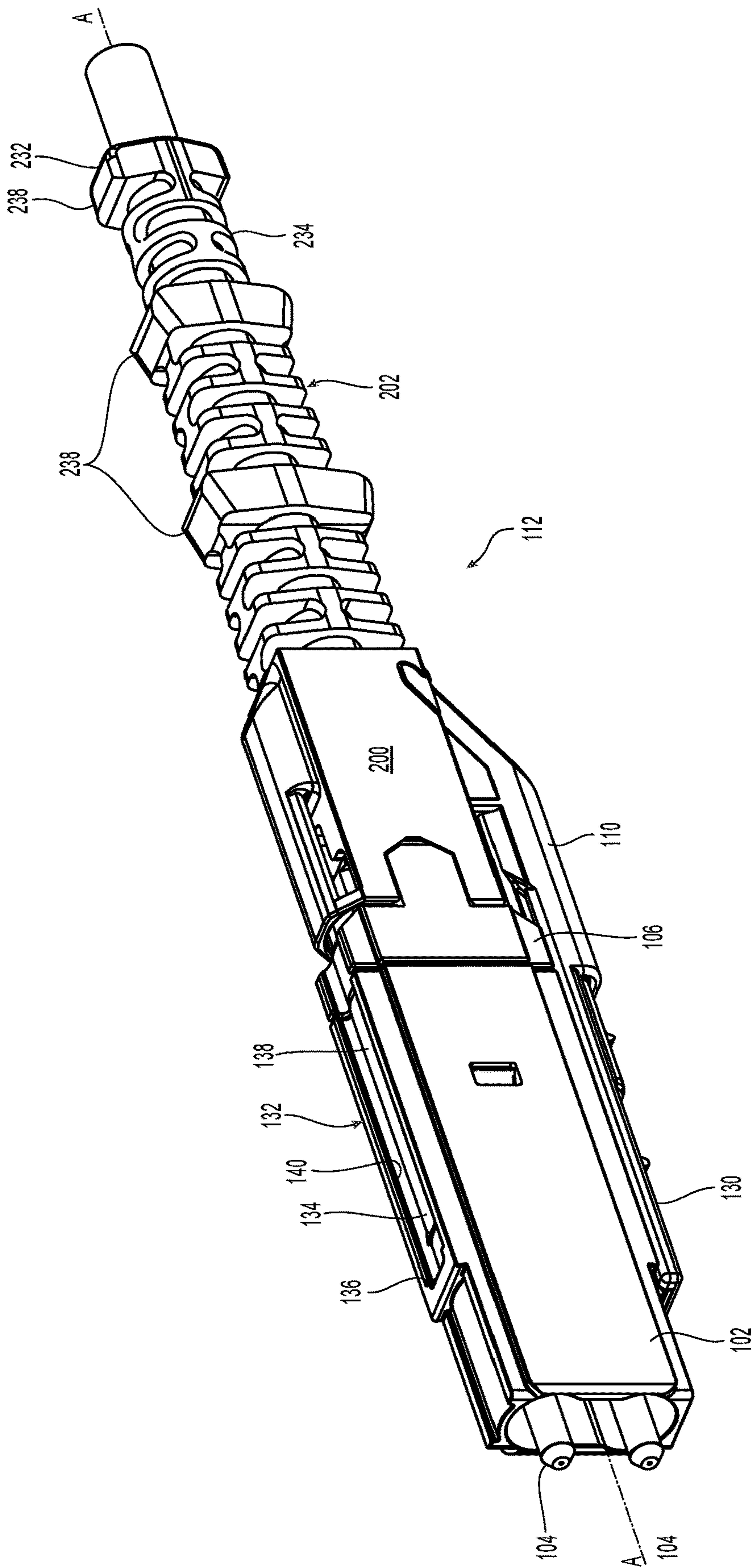


Fig. 2

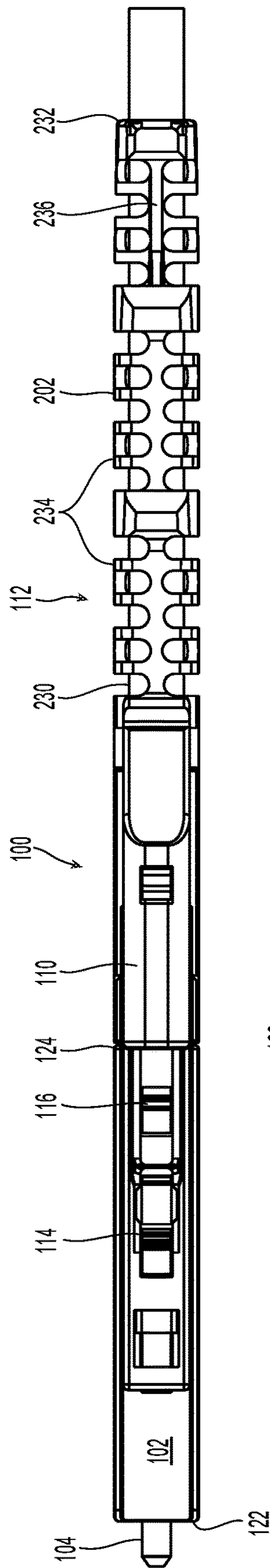


Fig. 3

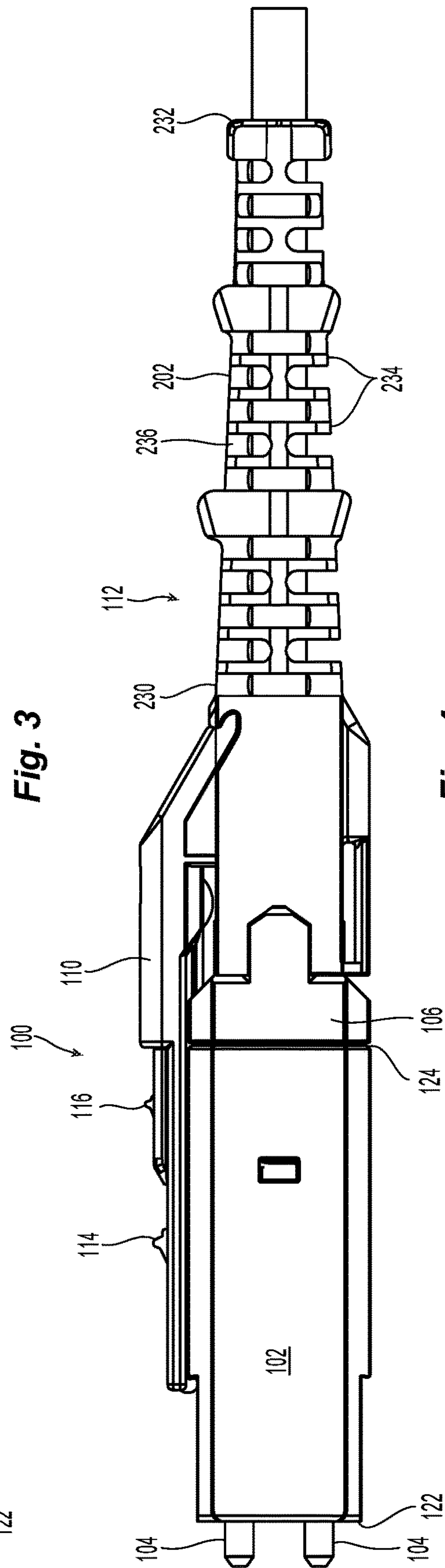


Fig. 4

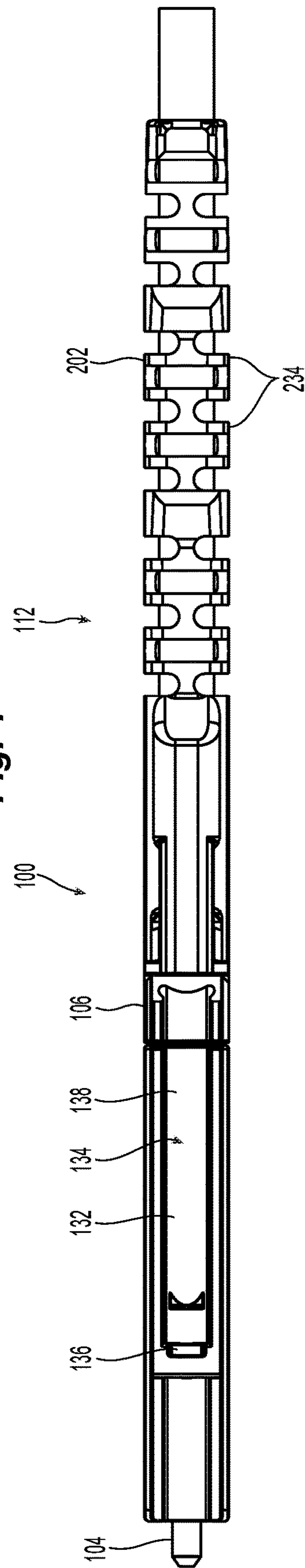


Fig. 5

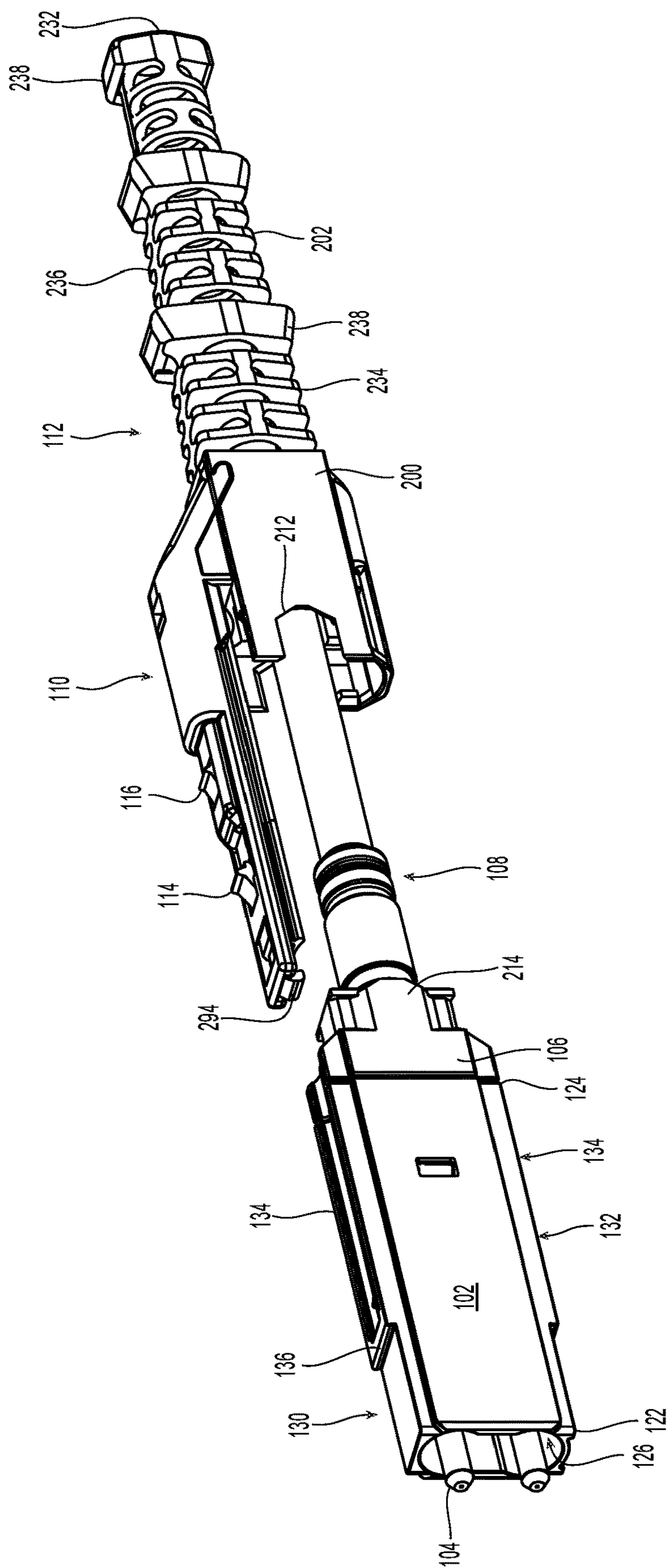


Fig. 6

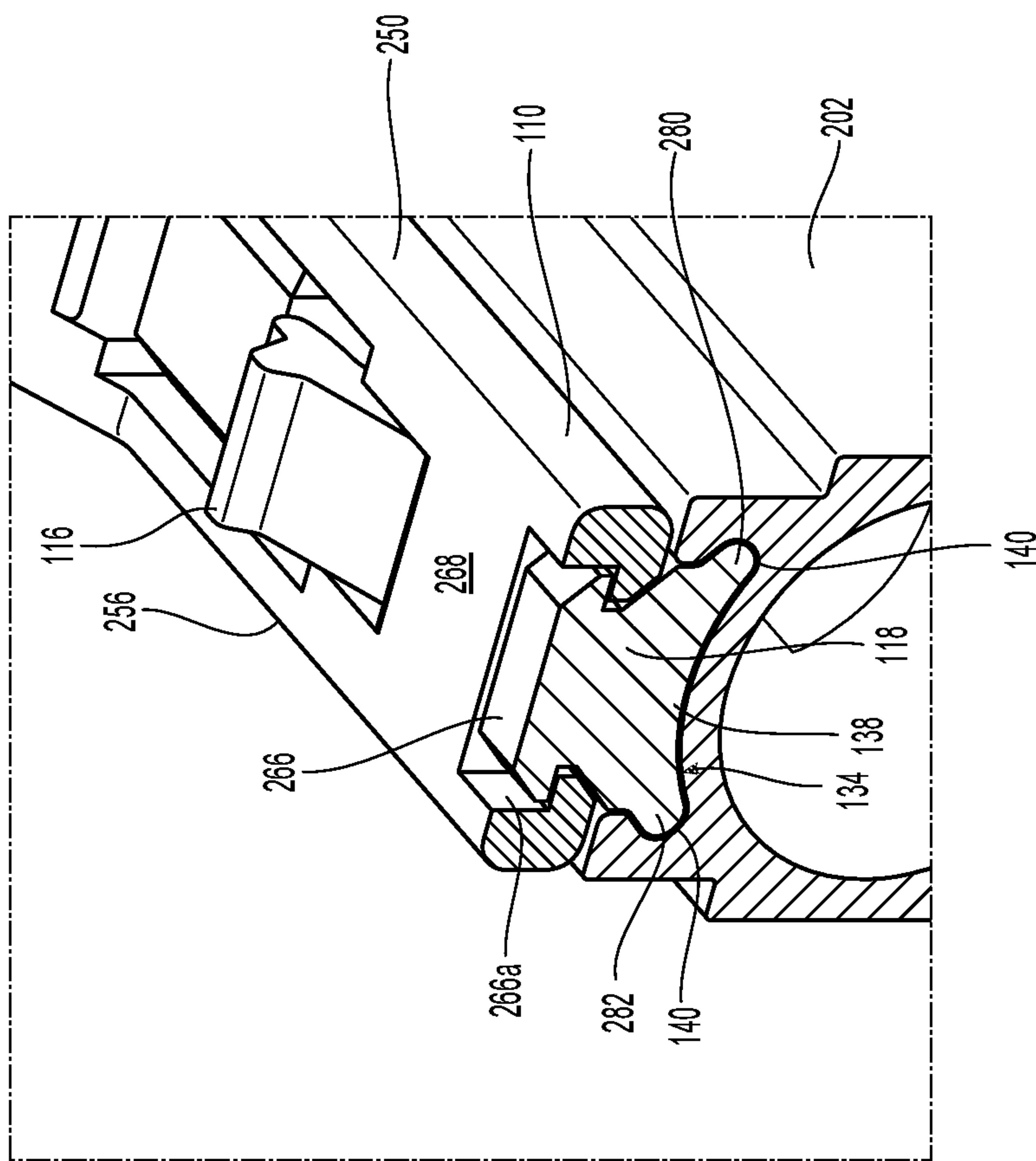


Fig. 7

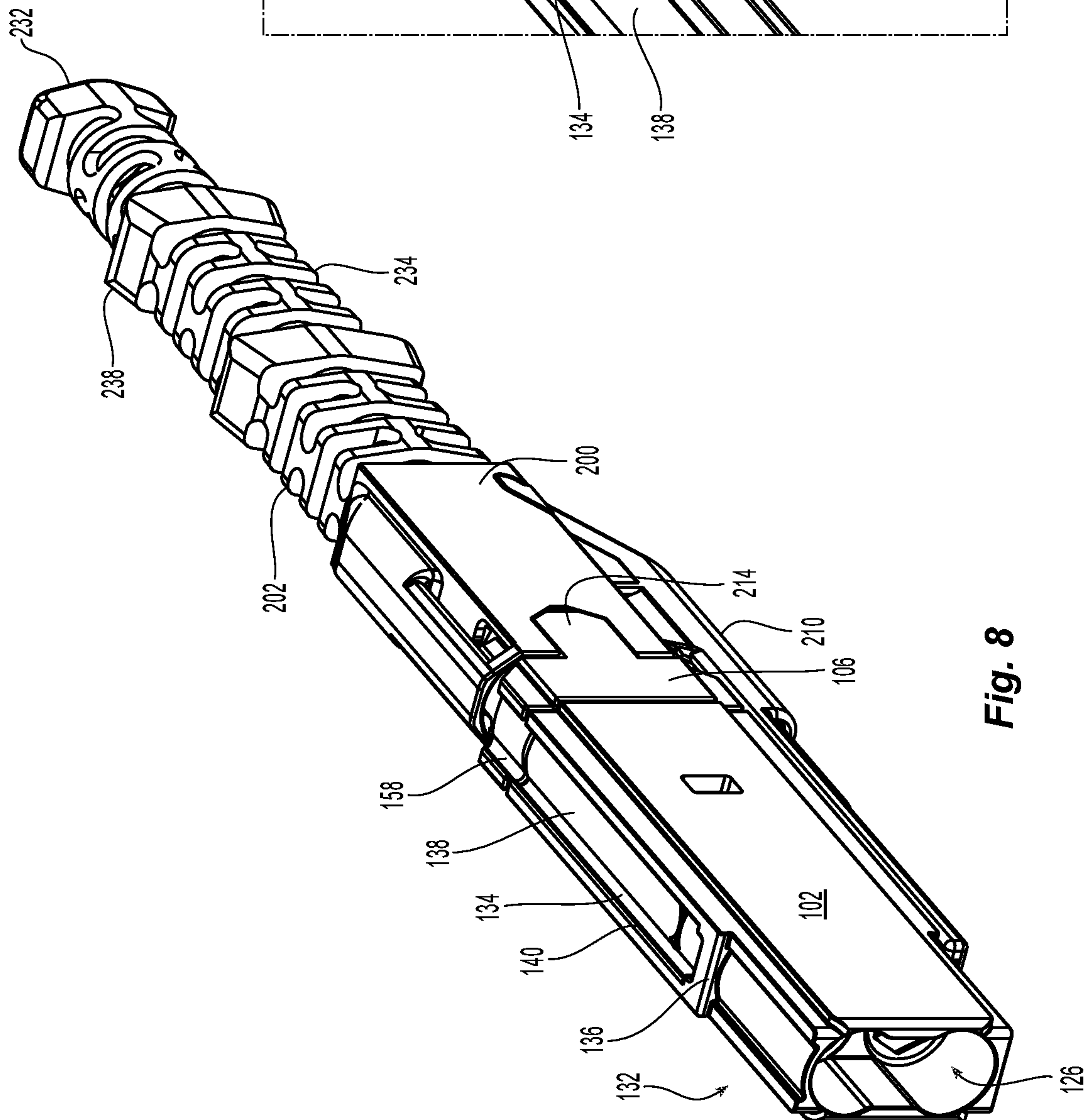


Fig. 8

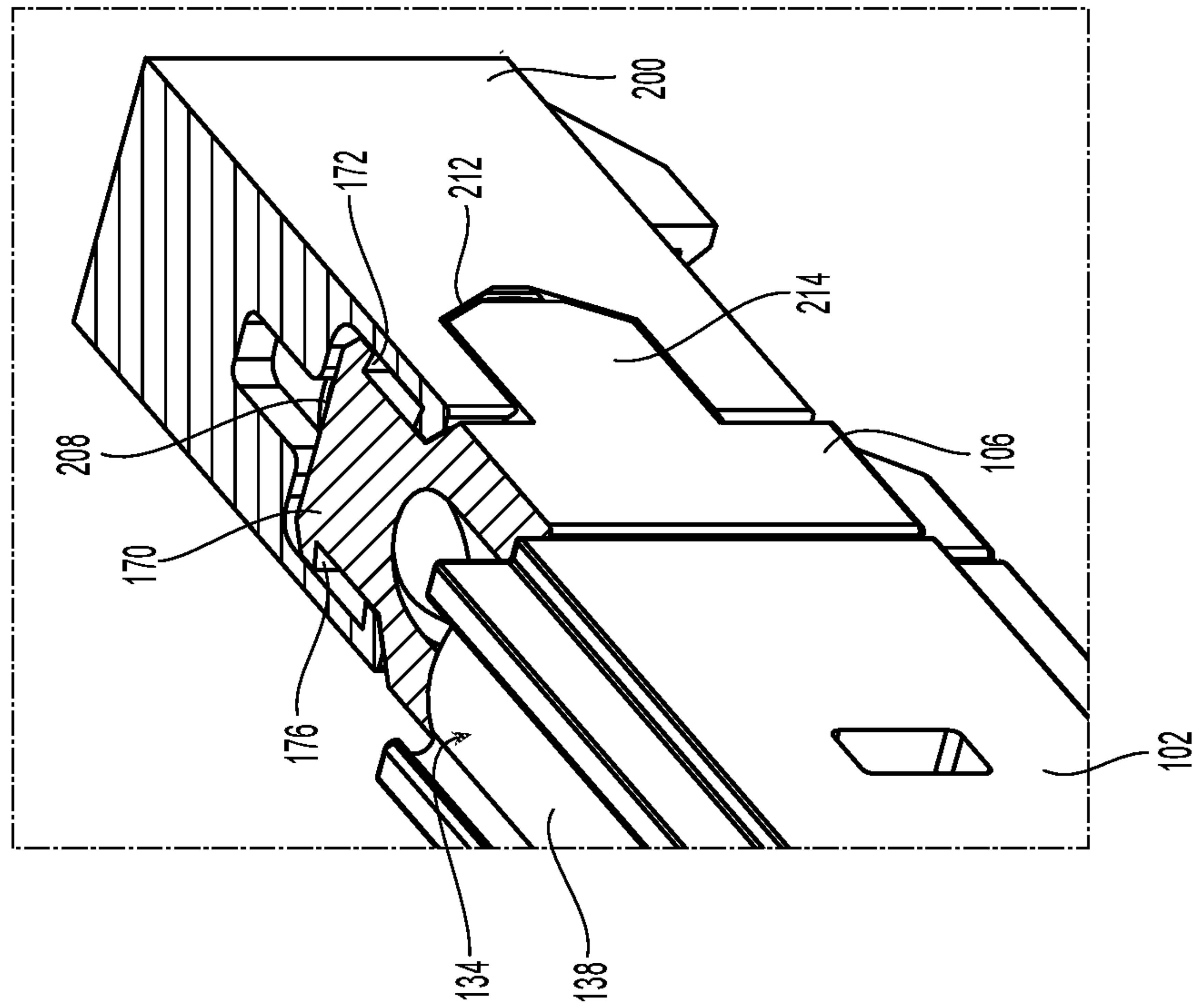


Fig. 9

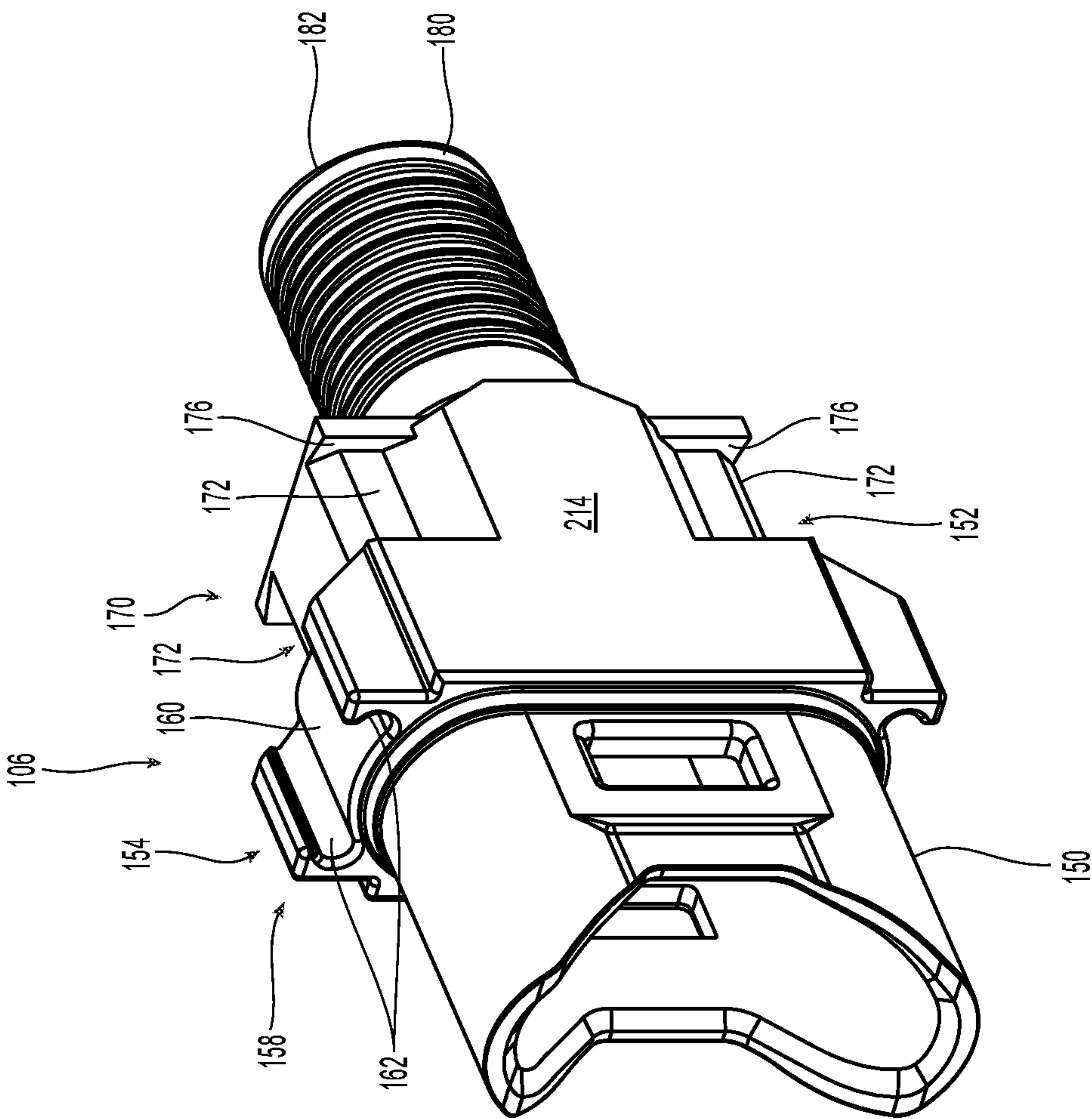


Fig. 10

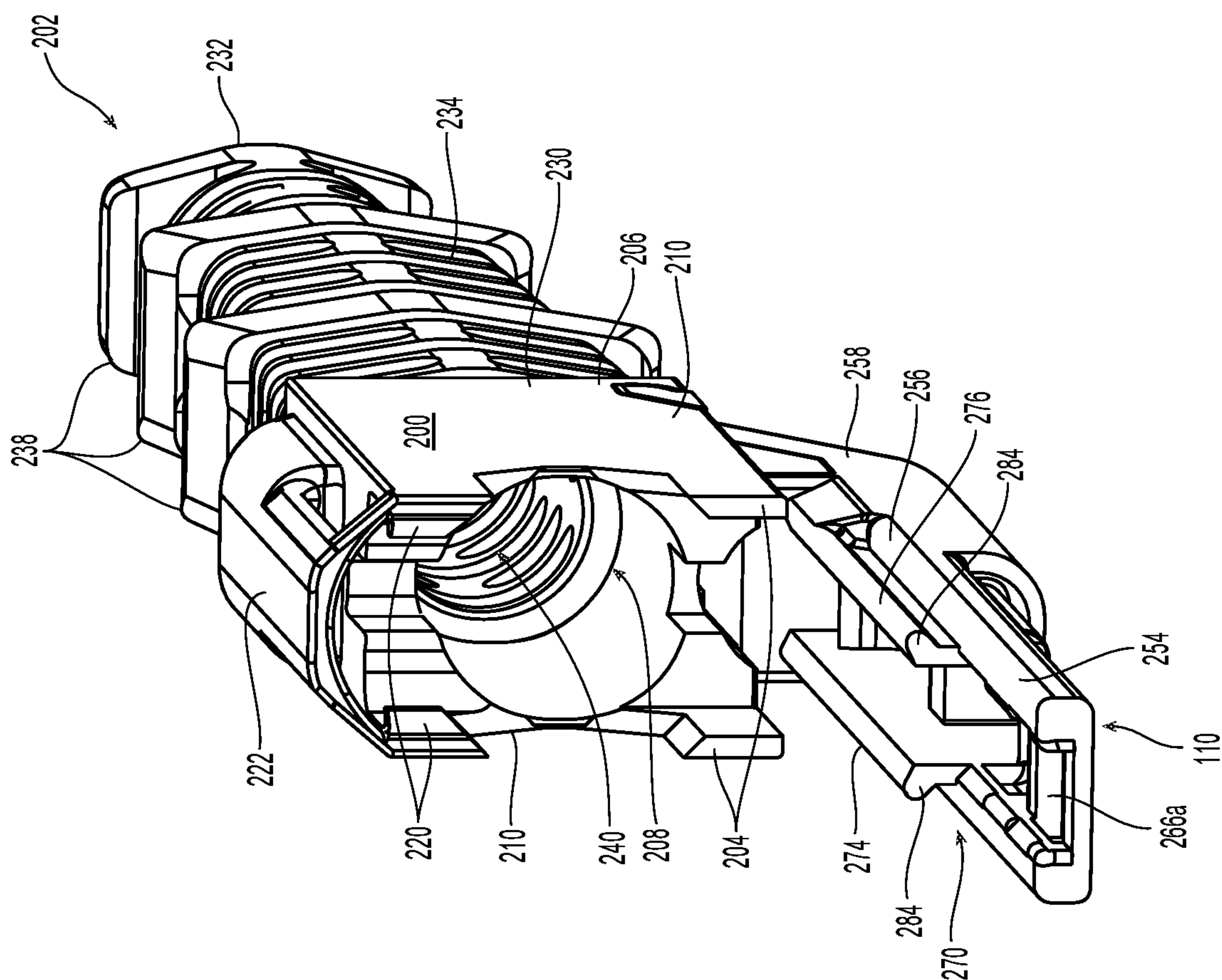


Fig. 11

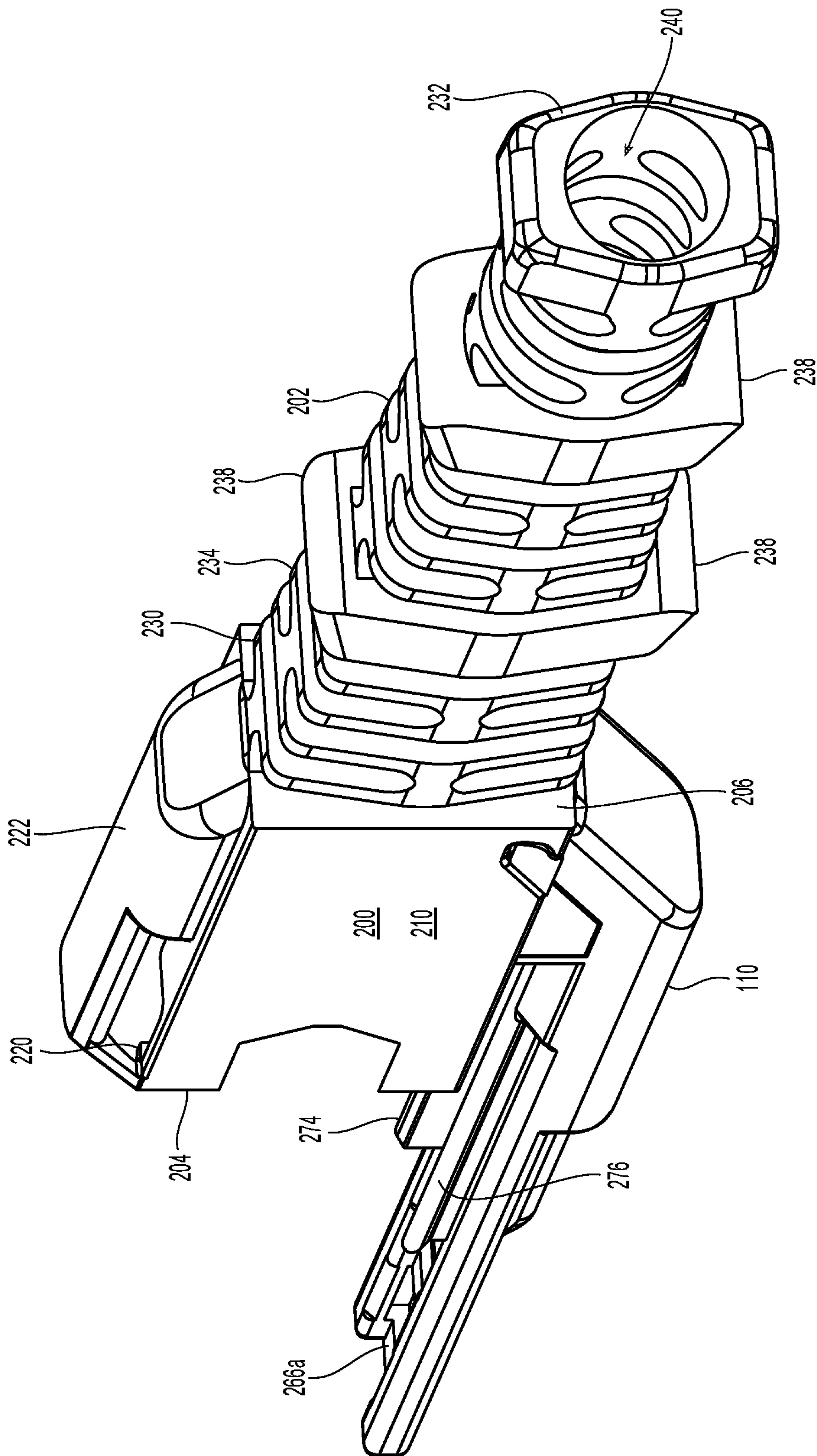


Fig. 12

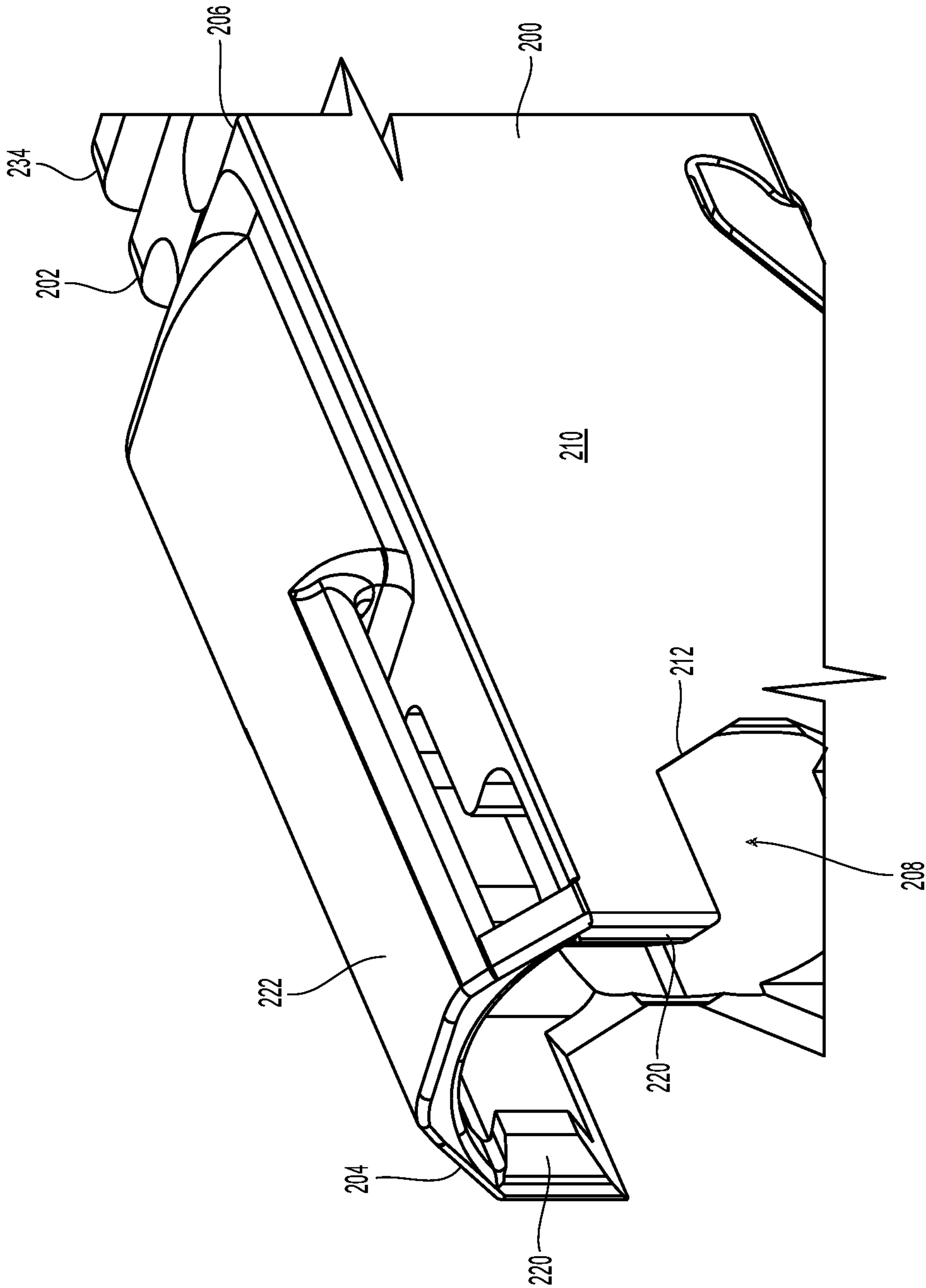


Fig. 13

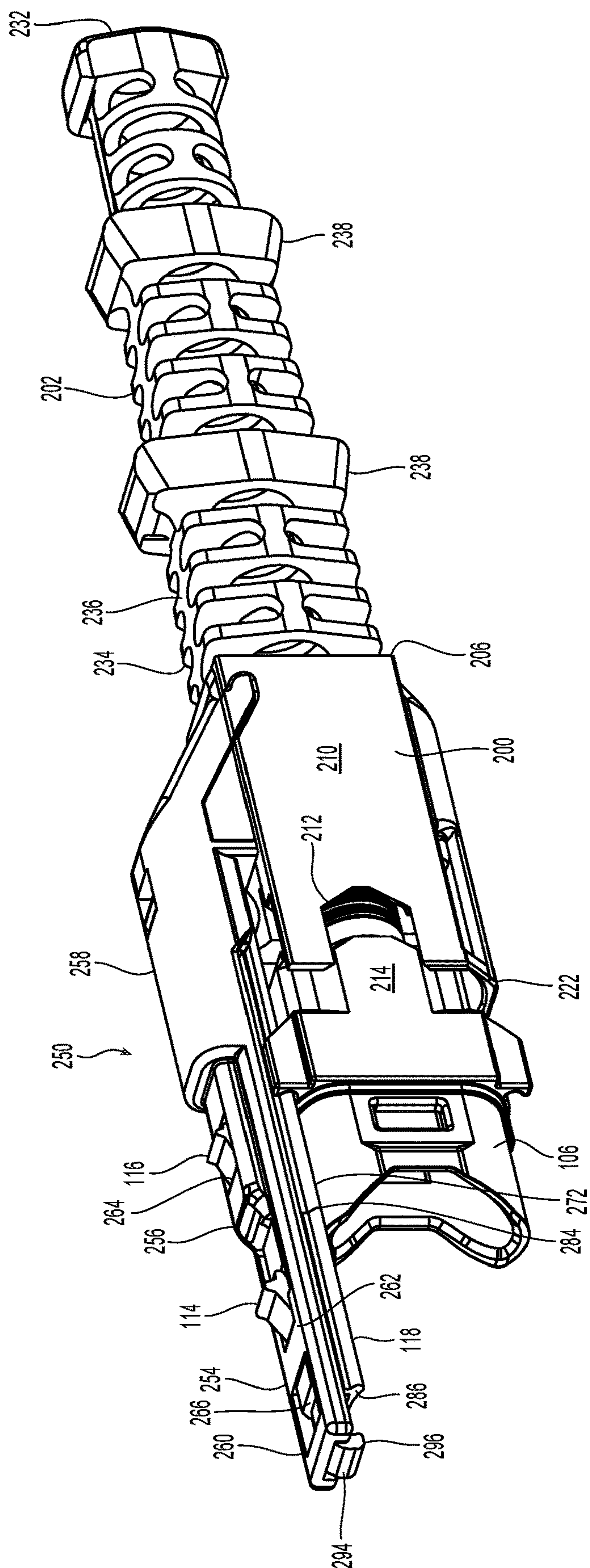


Fig. 14

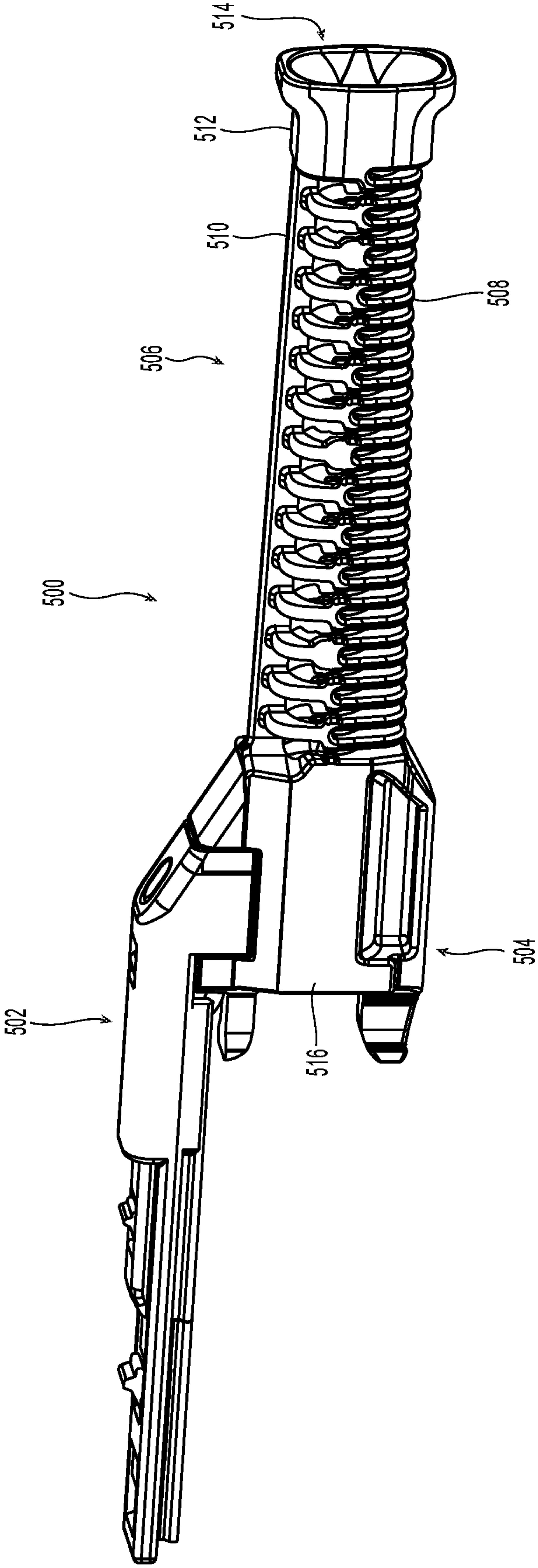


Fig. 16

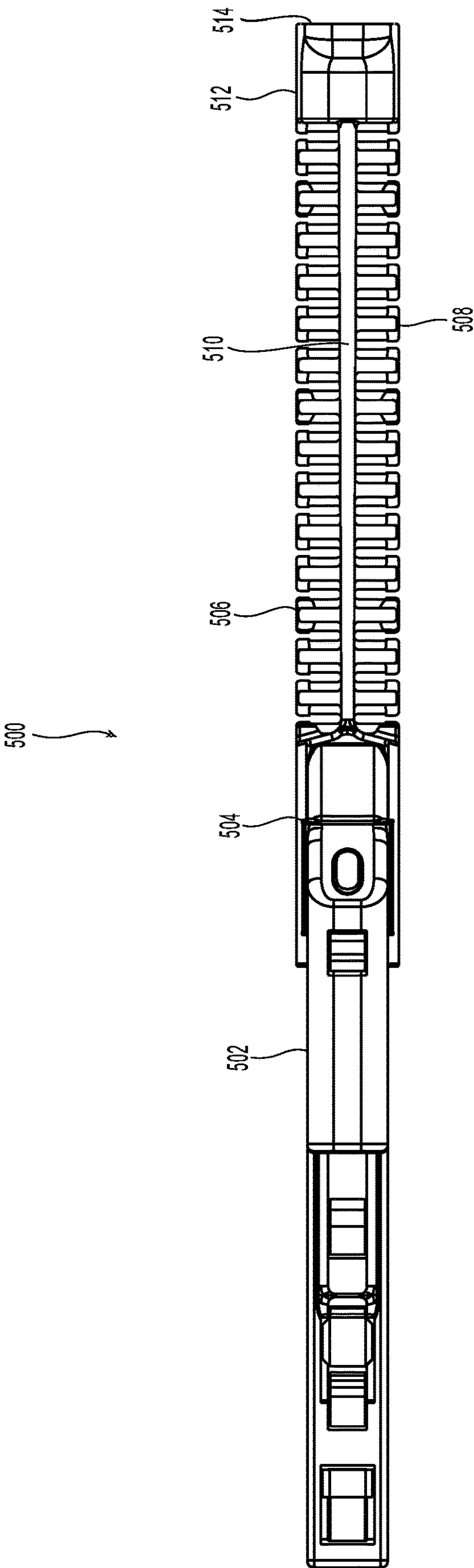


Fig. 17

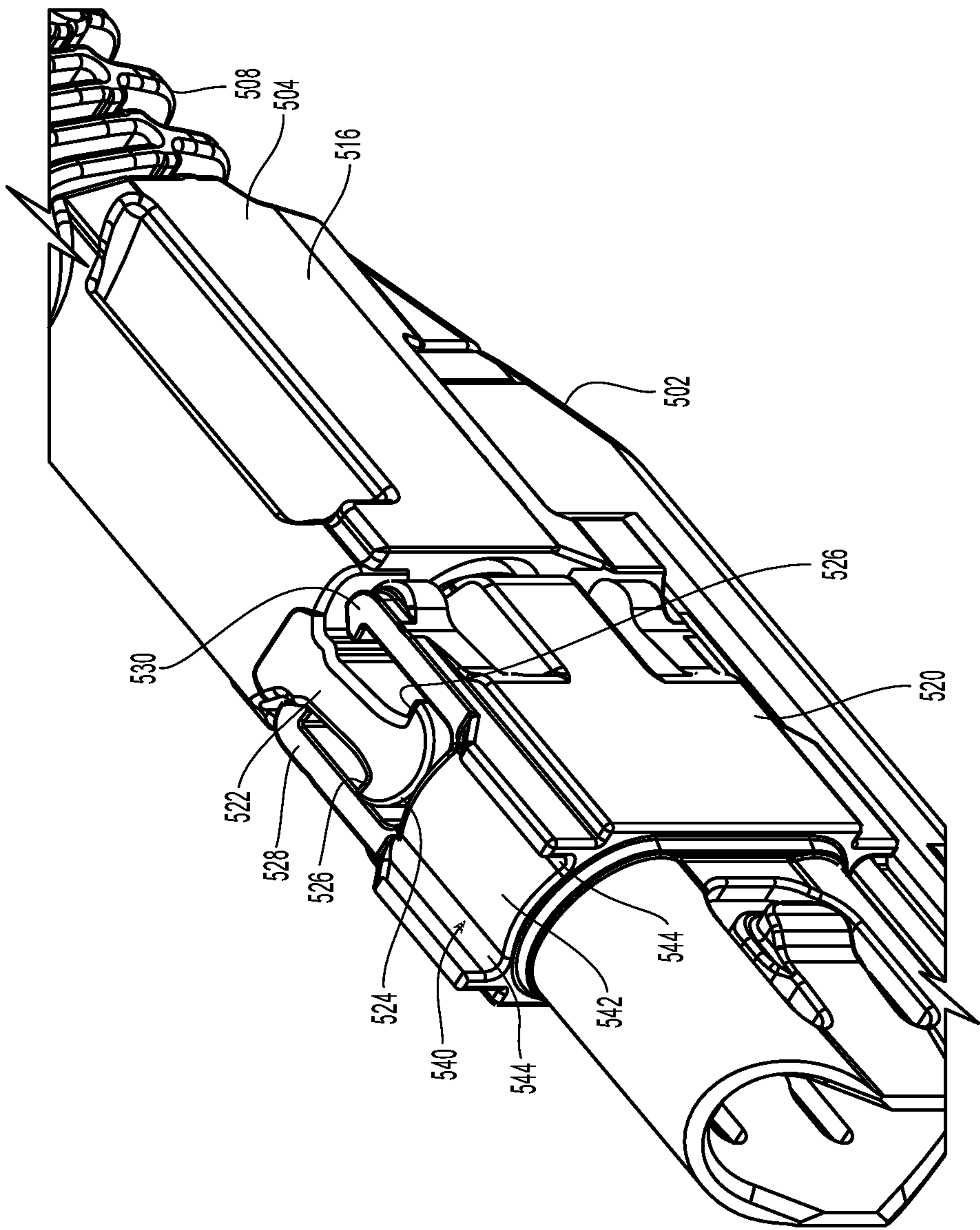


Fig. 18

US 11,906,794 B2

1

**FLEXIBLE PUSH-PULL BOOT AND CRIMP
BODY FOR FIBER OPTIC CONNECTOR**

This application claims priority of U.S. Provisional Patent Application Ser. Nos. 62/653,706, filed on Apr. 6, 2018, and 62/793,198, filed on Jan. 16, 2019; and under 35 U.S.C. § 120 to U.S. patent application Ser. No. 17/045,068, filed on Oct. 2, 2020, all of the contents of which are incorporated by reference.

BACKGROUND OF THE INVENTION**Field of the Invention**

Fiber optic connectors, and the locations where they are installed, are becoming smaller, requiring a higher density application. The fiber optic connectors have been reduced in size such that a person cannot easily grasp individual fiber optic connectors mounted in a receptacle in the high-density areas. Thus, it can be very difficult to install a fiber optic connector in, and uninstall from, its respective receptacle. Adjacent fiber optic connectors are generally located too close to allow manual insertion and removal of a single fiber optic connector using the connector's outer housing as intended, particularly, when used in higher density applications. Some solutions to the smaller areas include push-pull tabs or projections connected to the fiber optic connector, either as an additional component or as an integral part of the fiber optic connector, usually the outer housing.

While these push-pull tabs provide a solution to the insertion and removal of some fiber optic connectors, there is still an issue with the optical fibers and optical cables getting tangled around the tabs. This could lead to the push-pull tabs being removed or broken, providing the user with no real options for removing the fiber optic connectors. Additionally, in a high density environment, there may be some confusion as to which fiber optic connector a particular push-pull tab belongs to.

While a boot may be used for pushing a fiber optic connector into a receptacle, they are generally not intended to be used to remove a fiber optic connector. The boot is generally used for strain relief of the optical fibers secured within the fiber optic connectors. In many connectors, the boot simply cannot be used for fiber optic connector removal as the boot is not attached to the appropriate structures, such as the outer housing.

Additionally, the typical boot on a fiber optic connector cannot convey the polarity of the fiber optic connector to which it is attached.

The present invention is therefore directed to a boot that can be used with a fiber optic connector to insert into and remove from a receptacle. The boot can also be detached from a portion of the fiber optic connector and reinstalled in a different configuration to identify a polarity of the fiber optic connector.

SUMMARY OF THE INVENTION

The present invention is directed to a boot for a fiber optic connector, the fiber optic connector having a housing, at least two fiber optic ferrules, and a crimp body, the boot that includes a center portion having a front end and a back end, a first longitudinal opening extending between the front end and the back end to receive a portion of the crimp body and a fiber optic cable, a back portion attached to the center portion and extending away from the front end of the center portion, the back portion defining a second longitudinal

2

opening that is in communication with the first longitudinal opening, the back portion having grasping portions to allow a user to push and pull on the boot, and a front extension portion connected to the center portion and engageable with the fiber optic connector, the front extension portion extending forward and beyond the front end of the center portion and having at least one latch to engage a receptacle.

In some embodiments, the boot is connectable to one of a first side and a second side of the fiber optic connector to determine a polarity of the fiber optic connector.

In some embodiments, the boot further includes a first engagement member to cooperate with a corresponding second engagement member on the crimp body to removably attach the boot to the crimp body.

In some embodiments, pulling on the boot causes the first engagement member to slide relative to the second engagement member thereby pulling the front extension rearwardly releasing the fiber optic connector from the receptacle.

In another aspect, the invention is directed to a combination of a boot and a crimp body for a fiber optic connector, the fiber optic connector having a housing, at least two fiber optic ferrules, and a spring push, the combination that includes a boot that further includes a center portion having a front end and a back end, a first longitudinal opening extending between the front end and the back end to receive a portion of the crimp body and a fiber optic cable, a back portion attached to the center portion and extending away from the front end of the center portion, the back portion defining a second longitudinal opening that is in communication with the first longitudinal opening, the back portion having grasping portions to allow a user to push and pull on the boot, a front extension portion connected to the center portion and engageable with the fiber optic connector, the front extension portion extending forward and beyond the front end of the center portion and having at least one latch to engage a receptacle, and a crimp body that additionally includes a front portion configured to be disposed at least partially in the housing, a rear portion that extends rearwardly away from the front portion and provides an outer surface to receive a crimp band therearound, and a central portion disposed between the front and rear portions, wherein the boot has a first engagement member to cooperate with a corresponding second engagement member on the crimp body to removably attach the boot to the crimp body, the second engagement member being disposed on the central portion of the crimp body.

Additional features and advantages of the invention will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the invention as described herein, including the detailed description which follows, the claims, as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description of the present embodiments of the invention, and are intended to provide an overview or framework for understanding the nature and character of the invention as it is claimed. The accompanying drawings are included to provide a further understanding of the invention and are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments of the invention, and together with the description serve to explain the principles and operations of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top perspective view of one embodiment of a fiber optic connector with a crimp body, a boot, and a front extension according to the present invention;

US 11,906,794 B2

3

FIG. 2 is a bottom perspective view of the fiber optic connector in FIG. 1;

FIG. 3 is a top plan view of the fiber optic connector in FIG. 1;

FIG. 4 is a side elevation view of the fiber optic connector in FIG. 1;

FIG. 5 is a bottom plan view of the fiber optic connector in FIG. 1;

FIG. 6 is a front perspective view of the fiber optic connector in FIG. 1 with the boot and front extension detached from the crimp body and the connector housing;

FIG. 7 is a cross sectional view of the front extension, latch body, and connector housing;

FIG. 8 is bottom perspective view of the front extension, crimp body, and boot from the fiber optic connector in FIG. 1;

FIG. 9 is a partial cross section of the crimp body and boot at the connection of these two components;

FIG. 10 is perspective view of the crimp body of the fiber optic connector in FIG. 1;

FIG. 11 is a bottom perspective view from the front of the boot and the front extension of the fiber optic connector in FIG. 1 down the opening therein;

FIG. 12 is a rear and bottom perspective view of the boot and the front extension of the fiber optic connector in FIG. 1 down the opening therein;

FIG. 13 is an enlarged view of a portion of the bottom portion of the boot;

FIG. 14 is a side perspective view of the boot and front extension being attached to the crimp body;

FIG. 15 is a side view of the boot and the front extension being pulled rearwardly to disengage the fiber optic connector from a receptacle;

FIG. 16 is a second embodiment of a fiber optic connector with a crimp body, a boot, and a front extension according to the present invention;

FIG. 17 is a third embodiment of fiber optic connector with a crimp body, a boot, and a front extension according to the present invention; and

FIG. 18 is an enlarged view of the connection between the boot and the crimp body in the fiber optic connector of FIG. 16.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiment(s) of the invention, examples of which are illustrated in the accompanying drawings. Whenever possible, the same reference numerals will be used throughout the drawings to refer to the same or like parts.

Applicant notes that the term “front” or “forward” means that direction where the fiber optic connector would meet with another fiber optic connector or device, while the term “rear” or “rearward” is used to mean the direction from which the optical fibers enter into the fiber-optic ferrule or fiber optic connector. Thus, “front” is that part of the fiber optic connector on the left side of FIG. 1 and “forward” is out and to the left. “Rear” or “back” is that part of the fiber optic connector that is on the right side of the page and “rearward” and “backward” is toward the right.

One embodiment of a fiber optic connector 100 according to the present invention is illustrated in FIGS. 1-15. The fiber optic connector 100, as illustrated in FIGS. 1-6, may include a housing 102, fiber optic ferrules 104 (which may be included in a ferrule assembly as disclosed in PCT/2018/066523), a crimp body 106, a crimp ring and heat shrink

4

tube 108, a front extension 110 that is a part of strain relief boot 112. As discussed in more detail below, the crimp body 106, the front extension 110, and a strain relief boot 112 are the focus of this application. The front extension 110 also functions as a push-pull mechanism or latch component, whereby the front extension 110 has at least one latch and more preferably two latches 114, 116 on a latch body 118 that engage a receptacle (such as an adapter and/or a carrier) if used with the present invention. The front extension 110 also functions as a polarity key for the fiber optic connector 100. As described in more detail below, the fiber optic connector 100 can only be inserted into a receptacle in one orientation with the front extension 110 installed on the fiber optic connector 100. The housing 102 is symmetric about a longitudinal axis A through the fiber optic connector 100. Thus, without the front extension 110, the fiber optic connector 100 could be inserted into a receptacle in at least two ways. The front extension 110 prevents the fiber optic connector 100 from being inserted in all but one way—thereby giving it a polarity function.

Turning to the housing 102, the housing 102 has a main body 120 extending between a front end 122 and a rear end 124, and has an opening 126 extending therebetween. See also FIGS. 6 and 7. The fiber optic ferrules 104 are disposed within the opening 126 and have their front faces (for mating with other fiber optic ferrules) adjacent the front end 122. The crimp body 106 is also at least partially disposed within the opening 126 at the rear end 124 of the housing 102.

The outside of the housing 102 has many features that are integral to its use. First are the top surface 130 and the bottom surface 132. The top and bottom surfaces 130, 132 are preferably the same. Extending from the rear end 124 towards the front end 122 of the housing 102 on both the top surface 130 and the bottom surface 132 is a rail receiving portion 134. The rail receiving portion 134 as illustrated does not extend the entire length of the housing 102, but it could extend farther along the length of the housing 102 than shown in the figures if so desired. The rail receiving portion 134 has a stop surface 136 at the end of the rail receiving portion 134. The front extension 110 will make use of the stop surface 136 when the fiber optic connector 100 is inserted into or removed from various structures as discussed in more detail below.

The rail receiving portion 134 has a central portion 138 and two lobe sections 140, one lobe on each side of the central portion 138. As a result, the rail receiving portion 134 looks like part of a profile of a dog bone. This configuration matches that of the bottom surface of the front extension 110 (latch component or push-pull mechanism) to form a sliding dove-tail configuration. See FIG. 7. Other configurations are possible, such as, for example, a cap with undercuts (essentially an umbrella or a T-shape configuration).

The fiber optic connector 100 also includes a crimp body 106. The crimp body 106 has a front portion 150 that is designed to interact and connect with the housing 102 and a spring push (not shown) that is used in conjunction with the fiber optic ferrules 104 in the opening 126 thereof. The crimp body 106 has a central portion 152 that fits against the rear end 124 of the housing 102. The central portion 152 has a first portion 154 that includes a rail receiving portion 158 on both a top side 154 and a bottom side 156. The rail receiving portion 158 has a central portion 160 and two lobe sections 162, one lobe on each side of the central portion 160 that matches the same structure 134 on the housing 102 to engage the front extension 110.

The central portion 152 has a second, more rearward portion 170 that include two notches 172 on both the top side

US 11,906,794 B2

5

154 and the bottom side 156. At a rearward end 174 of each of the four notches 172 (two on the top side 154 and two on the bottom side 156) are forward facing surfaces 176 to engage latches on the boot 112. The notches 172 and the forward-facing surfaces 176 are involved in the connection of the boot 112 (and the front extension 110) to the crimp body 106 and the housing 102 as explained below.

The crimp body 106 has a rear portion 180 that extends behind the central portion 152 and the housing 102 and provides an outer surface 182 to receive a crimp band (e.g., crimp ring and heat shrink tube) therearound. Extending through the crimp body 106 is an opening 184 through which optical fibers/optical fiber cable can pass between the fiber optic ferrules 104 and the boot 112. Although the design will allow for the use of a crimp band to attach the aramid yarn from a fiber optic cable, the crimp band is optional, and the fiber optic connector will work without a crimp band when the aramid yarn is not present. Further, when the crimp band is not used, the crimp body would require the outer surface 182.

Turning now to the boot 112, the boot 112 includes the front extension 110, a center portion 200 that is disposed between the front extension 110 and a ribbed back portion 202. It should be noted that the front extension 110 is preferably an integral part of the center portion 200, but it could be removably attached to the center portion 200 and still fall within the scope of the present invention.

The center portion 200 has a front end 204 and a back end 206 with a first longitudinal opening 208 extending throughout the center portion 200. The first longitudinal opening 208 receives at least a portion of the crimp body 106, including at least the rear portion 180 that extends behind the central portion 152 and the outer surface 182 with the crimp band. The first longitudinal opening 208 also receives the rearward portion 170 of the central portion 152 of the crimp body 106 as well as the notches 172 and the forward-facing surfaces 176. See FIG. 9.

The center portion 200 also has sides 210 that help to define the first longitudinal opening 208. The sides 210 may also have cut-outs 212 that receive a portion 214 of the crimp body 106. The cooperation between the cut-outs 212 and the portion 214 of the crimp body 106 assist in alignment and the integrity of the combination of the crimp body 106 and the center portion 200. However, it should be noted that the sides 210 could be solid and cover the overlapping portion of the crimp body 106. See, e.g., FIG. 16.

Within the first longitudinal opening 208 and extending from the sides 210 are two projections or latches 220 that extend into the first longitudinal opening 208. When the boot 112 is attached to the crimp body 106, the projections or latches 220 are disposed within the two notches 172 on one of the top side 154 or bottom side 156, depending on the orientation of the boot 112. In the fully engaged position, the projections or latches 220 are farthest from the forward-facing surfaces 176 that at least partially define the two notches 172. See FIG. 9. At this position, the front end 204 of the center portion 200 should be touching the first portion 154 of the central portion 152 of the crimp body 106. See FIGS. 1, 8, and 9. The center portion 200 also has a bridge portion 222 that connects the sides 210 with the projections or latches 220. This bridge portion 222 performs two functions. First, as seen in FIGS. 2 and 8, the bridge portion 222 blocks the rail receiving portion 158 when the front extension 110 is oriented on the other side of the fiber optic connector 100. See FIG. 8. This bridge portion 222 assists in preventing the rail receiving portion 158 from snagging optical fibers and optical fiber cables when the fiber optic

6

connector 100 is installed. Second, when a user pushes on the bridge portion 222 toward the first longitudinal opening 208, the projections or latches 220 (and the sides 210) are pushed outward and clear of the notches 172 and the forward-facing surfaces 176. This allows the boot 112 (and center portion 200) to be removed from the crimp body 106 and from the fiber optic connector 100 if so desired.

It should be noted that while there are two projections or latches 220 and two notches 172 on each side, there may be more or fewer. For example, there may just be one latch and one corresponding notch. Alternatively, the latching of the boot 112 to the crimp body 106 may not be on an outside surface of the crimp body 106. Instead, such latching may occur on an inside surface of the crimp body 106 and may not be visible from the outside. For example, the notches 172 and the forward-facing surfaces 176 may be inside the rearward portion 170 such that from outside, the rearward portion 170 will have a smooth continuous surface merging with the portion 214 of the crimp body. In another example, latches 220 may be extending from the bridge portion 222 into an internal groove inside or underneath the top surface of the rearward portion 170 (i.e., the portion between the forward-facing surfaces 176). In this scenario, the latches 220 would be facing upward or downward rather than sideways as shown in FIG. 11, for example.

The ribbed back portion 202 extends between a front end 230 and a back end 232 and is made of a plurality of rib members 234. The ribbed back portion 202 is attached to the back end 206 of the center portion 200 and extends away from the front end 204. Thus, the ribbed back portion 202 makes the boot 112 longer. The ribbed back portion 202 also has a spine 236 that joins the plurality of rib members 234 together. Along the spine 236 are a number of grasping portions 238 that provide surfaces for the user to grasp. The user can then use the ribbed back portion 202 to either push the fiber optic connector 100 into a receptacle or to pull on the ribbed back portion 202, and the grasping portions 238 in particular, to pull the fiber optic connector 100 from a receptacle. The grasping portions 238 are illustrated as three annular members that are disposed along a length of the spine 236 and together with the plurality of rib members 234 form a second longitudinal opening 240 through the ribbed back portion 202. The first longitudinal opening 208 and the second longitudinal opening 240 are in communication with one another and form a pathway for the optical fibers/fiber optic cable to be inserted from back end 232 to the opening 126 in the housing so they can be fixed within the fiber optic ferrules 102 in the fiber optic connector 100.

The construction of the ribbed back portion 202 with the plurality of rib members 234 and the spine 236 provides sufficient strength to allow it to be used to install and remove the fiber optic connector while at the same time being flexible to provide strain relief to the optical fibers. The ribbed back portion 202 is illustrated as being asymmetrical about the second longitudinal opening 240, but could be of any appropriate shape and still fall within the scope of the present invention. Additionally, there could be different rib structures and grasping portions such as those illustrated in FIGS. 16 and 17 that also fall within the scope of the present invention.

The front extension 110 has a main body 250 and a latch body 118 that attaches to the main body 250. See FIGS. 6, 7, and 14. The main body 250 has a front portion 254, a middle portion 256, and a rear portion 258. Generally, the front portion 254 is where the latch body 252 attaches to the main body 250 and provides for the latching of the fiber optic connector 100 to a first receptacle such as an adapter.

US 11,906,794 B2

7

The middle portion **256** provides an area for the latching of the fiber optic connector **100** to a second receptacle such as a ganged carrier. The rear portion **258** has an area for a return element associated with the latch body **252** and also connects the front extension **110** to the center portion **200** of the boot **112**.

The front portion **254** has two windows **260** and **262** and the middle portion **256** has a window **264**. The window **262** of the front portion **254** and window **264** are to receive a latch **114**, **116** from the latch body **118** therethrough. The first window **260** is to receive a latch pad **266** on the latch body **118**. There are two latch **266** pads on the latch body **118** that cooperate with a groove **266a** in the main body **250** to secure the latch body to the main body **250**. The latch pads slide within the grooves to allow for the latching and unlatching the fiber optic connector **100**. A more detailed discussion of this feature is disclosed in PCT/2018/066523, which is incorporated by reference herein.

The middle portion **256** has an upper surface **268** that is higher than an upper surface **270** of the front portion **254**. This allows for the latching of a carrier and an adapter with the same device. On the bottom side **272** of the middle portion **256** are two extensions **274,276** that are a complementary configuration of a rail receiving portion **134** of the housing **102**. See FIG. 13. The latch body **118** also has the same rail portion configuration of two extensions **280,282** on the bottom thereof. This allows the main body **250** and the latch body **118** to be slidingly attached to the rail receiving portion **134** of the housing **102** and the rail receiving portion **158** of the crimp body **106**. When the latch body **118** is inserted into the front portion **254**, a front surface **284** of the two extensions **274,276** provides a pushing surface by which the main body **250** can push the latch body **118** in the rail receiving portion **134**. See also FIGS. 11 and 14. The front surface **286** of the two extensions **280,282** also provides a pushing surface to be used against the stop surface **136** of the housing **102**. See FIGS. 11 and 14. This allows for the user to exert a force on the boot **112** which is transferred through the main body **250** to the latch body **118** and to the housing **102** to insert the fiber optic connector **100** into a carrier and/or adapter.

Turning to FIGS. 1, 7, and 14, the latch body **118** has two latches for receptacles such as an adapter latch **114** and a carrier latch **116**. The latch body **118** may only have one of the latches, depending upon its uses and the needs of the user and the receptacles into which the fiber optic connector **100** is going to be inserted. The adapter latch **290** extends from a forward portion of the latch body **118** and protrudes through window **262** of the main body **250**. The carrier latch **116** also extends from the latch body **118**, from a rear portion thereof, and protrudes through the window **264** of the main body **250**. As is recognized from FIG. 4, the adapter latch **114** does not rise as high as the carrier latch **116**. The latch body **118** has a connector latch **294** as well. The connector latch **294** extends forward beyond the front surface **286** of the two extensions **280,282** to engage the stop surface **136**. The connector latch **294** has a downward curling portion **296** that provides a surface to engage the stop surface **136** to prevent the latch body **118** from moving rearwardly relative to the housing **102** as the boot **112** is pulled to disengage the fiber optic connector **100** from a receptacle as will now be explained.

Referring in particular to FIGS. 1, 6, 9, 14, and 15, the attachment, use, and the removal of the boot **112** on the fiber optic connector **100** will be explained. As is generally known in the art, a fiber optic connector would need to have the optical fibers terminated in the fiber optic ferrules before

8

a strain-relief boot can be attached to the fiber optic connector. In this case, the boot **112** with the center portion **200** and the front extension **110** are put onto the optical fibers/fiber optic cable as illustrated in FIG. 6. The optical fibers/fiber optic cable pass through the first longitudinal opening **208** and the second longitudinal opening **240** of the boot **112** and are secured in the fiber optic ferrules **104**. The jacket or covering on the optical fibers/fiber optic cable is then secured to the crimp body **106** with a crimp ring and heat shrink tube **108** or in any other manner that is appropriate. As seen in FIG. 6, the boot **112** is disposed on the optical fibers/fiber optic cable and the fiber optic connector has been assembled. As the boot **112** is moved to the fiber optic connector (to the left in FIG. 6), it is apparent that the front extension **110** will engage the rail receiving portion **158** of the crimp body **106** first and then the rail receiving portion **134** of the housing **102**. As the boot **112** is further pushed to the left in the figure, the rear portion **180** of the crimp body **106** enters the first longitudinal opening **208** followed by the rearward portion **170** of the central portion **152** of the crimp body **106**. As the connector latch **294** starts to engage the stop surface **136** of the housing **102**, the notches **172** and the forward facing surfaces **176** of the central portion **152** of the crimp body **106** also enter the first longitudinal opening **208**. See FIG. 1. FIG. 14 also illustrates (with the connector housing **102** removed for clarity) how the crimp body **106** engages the boot **112** and the latches **220** moving past the forward facing surfaces **176**. With the front end **204** of the center portion **200** disposed against the crimp body **106**, the cut-outs **212** receive the portion **214** of the crimp body **106**. As seen in FIG. 9, the projections or latches **220** are disposed within the two notches **172** and are at the front end of the notches **172**. At this point, the fiber optic connector **100** is as illustrated in FIGS. 1-5 and ready to be inserted into a receptacle. The user could push on the ribbed back portion **202**, the grasping portions **238**, the front extension **110**, or the center portion **200** to insert the fiber optic connector **100** into the receptacle.

To remove the fiber optic connector **100** from the receptacle, the user could pull on the ribbed back portion **202**, the grasping portions **238**, the front extension **110**, or the center portion **200**. Referring to FIG. 15, when the user pulls on one of those structures, the front extension **110**, the center portion **200**, and ribbed back portion **202** move relative to the crimp body **106** and the housing **102**, the projections or latches **220** sliding rearwardly within the two notches **172**. It is important to note that the frictional force between the boot and the connector housing and crimp body should be low. It is desirable to have clearance between the boot and the crimp band, crimp body, housing, and the cable. It is also desirable to have a boot material that has a low coefficient of friction, such as polypropylene. Furthermore, an elastomeric boot material is not preferred because the user could deform the internal surface of the boot and cause added friction due to squeezing or pinching the boot while pulling. A material with a Young's Modulus greater than 500 MPa or possibly greater than 1 GPa has been shown not to deform easily. See the arrows in FIG. 15. It is important to note that the latch body **118** (and the adapter latch **114** and carrier latch **116**) also does not move because the connector latch **294** has engaged the stop surface **136** of the housing **102**. As the front extension **110** moves rearwardly, the main body **250** slides relative to the latch body **118** (and housing **102**), pushing the adapter latch **114** and carrier latch **116** downward out of the windows and disengaging them from their respective receptacle.

US 11,906,794 B2

9

At this point the fiber optic connector **100** could be simply removed from the receptacle by pulling on the ribbed back portion **202**, the grasping portions **238**, the front extension **110**, or the center portion **200**. The engagement of the projections or latches **220** with the forward-facing surfaces **176** prevents the boot **112** from being disengaged from the crimp body **106** and the housing **102**. However, as noted above, the user could push on the bridge portion **222**, which allows the boot **112** to be disengaged from the crimp body **106** and the housing **102**. At this point the boot **112** could be rotated about the optical fibers/fiber optic cable and reattached on the opposite side, thereby changing the polarity of the fiber optic connector **100**.

FIGS. **16-18** illustrate another embodiment of a boot **500** for use with a fiber optic connector. The boot **500** has a front extension **502**, a center portion **504**, and a ribbed back portion **506**. The front extension **502** of this embodiment is the same as that described above and will not be addressed any further. The ribbed back portion **506** functions in the same way as ribbed back portion **202** in that it can be used to push and pull on the fiber optic connector. It does have a different configuration with regard to the plurality of rib members **508** and the spine **510**, but still provides sufficient strength to allow it to be used to install and remove the fiber optic connector while at the same time being flexible to provide strain relief to the optical fibers. The ribbed back portion **506** has only a single grasping portion **512** at the back end **514**, although more grasping portions could be added. As can be seen in the figures, the spine **510** connects the plurality of rib members **508** from the center portion **504** to the grasping portion **512**.

The center portion **504** of the boot **500** is similar to the embodiment above, but with a few differences. First, the sides **516** that help to define the longitudinal opening therein do not have cut-outs. The sides of a crimp body **520** to be used with the boot **500** would not have to extend as far into the center portion with the engagement member noted below.

Second, the way of engagement between the center portion **500** and the crimp body **520** has changed. See FIG. **18**. In this figure, the top and bottom of the center portion **500** have a single engagement member, a single element **522** that replaces the two projections or latches **220** in the prior embodiment. The single element **522** has a shape that is rounded at the front **524** and then has two rearward facing surfaces **526** to engage two inward facing latches **528**, **530** in the crimp body **520**. The interaction between the center portion **504** and the crimp body **520** is the same as discussed above. The boot **500** is advanced toward the crimp body **520** and the rounded front portion **524** causes the two inward facing latches **528**, **530** in the crimp body **520** to spread apart, allowing the engagement member **522** to be disposed between them. As the user pulls on the boot **500** to remove the fiber optic connector from a receptacle, the engagement member **522** moves relative to the two inward facing latches **528**, **530**. As discussed above, this movement causes the front extension **502** to release the latches and the engagement member **522** contacts the two inward facing latches **528**, **530** to pull the fiber optic connector from the receptacle. Once the fiber optic ferrule is removed from the receptacle, the user can pull of the center portion **504** while holding the crimp body or housing and disengage the boot **500** from the crimp body with a little more force than was necessary to disengage the fiber optic connector from the receptacle.

One other alternative in this embodiment that can be used on the other embodiment is the rail receiving portion **540** on

10

both sides. The rail receiving portion **540** has a central portion **542** and two lobe sections **544** to engage the front extension **502**. However, the lobe sections **542** not as closed as the two lobe sections **162**. This allows the rail receiving portion **540** to act more as an alignment feature allowing the front extension **502** to be aligned with and then inserted in to the rail receiving portion **540** from above it, rather than being inserted from the rear side as in the prior embodiment.

It will be apparent to those skilled in the art that various modifications and variations can be made to the present invention without departing from the spirit and scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed:

1. A fiber optic connector having a boot, a crimp body, and a housing having at least two optical fibers therein, the fiber optic connector comprising:

a front end opening in the housing, the housing having a pair of short sides forming a top and a bottom and a pair of long sides joining the top and the bottom, the at least two optical fibers spaced apart between the top and the bottom formed by the pair of short sides, a separation between the top and the bottom is more than a separation between individual ones of the pair of long sides; the crimp body positioned rearward of the front end of the housing, the crimp body having a rear portion; and the boot receiving the rear portion of the crimp body and having a front extension, the front extension extending towards the front end of the housing and attached to the housing forward of a center portion of the boot, wherein the crimp body and the boot each have a respective contiguous longitudinal opening to accommodate the at least two optical fibers having ends terminated forward of the front end opening of the housing, and

wherein the longitudinal opening extends through a back portion of the boot rearward of the center portion of the boot.

2. The fiber optic connector according to claim 1, wherein the back portion has a ribbed structure with openings on an outside surface along a length of the back portion to provide strain relief to the at least two optical fibers.

3. The fiber optic connector according to claim 1, wherein the ends of the at least two fibers are terminated in respective two single fiber ferrules.

4. The fiber optic connector according to claim 3, wherein the two single fiber ferrules have respective front ends exposed forward of the front end opening in the housing.

5. The fiber optic connector according to claim 1, wherein the boot is movable longitudinally relative to the housing upon application of a pull force, and wherein after application of the pull force, the boot and the housing are rotatable relative to each other to change a polarity of the fiber optic connector.

6. The fiber optic connector according to claim 1, wherein the front extension portion has at least one latch.

7. The fiber optic connector according to claim 6, wherein the front extension portion has two latches separated from each other on the front extension.

8. The fiber optic connector according to claim 1, wherein the center portion of the boot engages the rear portion of the housing.

9. The fiber optic connector according to claim 1, wherein a connection of the boot to the housing in a first relative orientation determines a first polarity of the fiber optic

US 11,906,794 B2

11

connector and a connection of the boot to the housing in a second relative orientation determines a second polarity of the fiber optic connector.

10. The fiber optic connector according to claim 9, wherein the first relative orientation and the second relative orientation differ by 180° about a longitudinal axis of the fiber optic connector.

11. The fiber optic connector according to claim 1, wherein the back portion has a grasping portion at a rear end of the back portion to allow a user to push and pull on the boot.

12. The fiber optic connector according to claim 1, wherein the boot is slidable relative to the housing.

13. The fiber optic connector according to claim 1, wherein the front extension is an integral part of the center portion.

14. The fiber optic connector according to claim 1, wherein the center portion has sides with cutouts.

15. The fiber optic connector according to claim 1, wherein a material of the boot has a Young's modulus greater than 500 MPa.

16. A fiber optic connector having a boot, a crimp body, and a housing having two optical fibers terminated respectively within two fiber optic ferrules therein, the fiber optic connector comprising:

a front end opening in the housing for the two fiber optic ferrules, the housing having a pair of short sides forming a top and a bottom and a pair of long sides joining the top and the bottom, a separation between the top and the bottom is more than a separation between individual ones of the pair of long sides, the two fiber optic ferrules being spaced apart from each other between the top and the bottom but equidistant from each of the pair of long sides;

the crimp body positioned rearward of the front end of the housing, the crimp body having a rear portion to receive the two optical fibers; and

the boot receiving the rear portion of the crimp body and having a front extension, the front extension extending towards the front end of the housing and attached to the housing via at least one latch forward of a center portion of the boot, wherein the crimp body and the boot have a longitudinal opening to accommodate the two optical fibers having ends terminated forward of the front end opening of the housing, and

wherein the longitudinal opening extends through a back portion of the boot rearward of the center portion of the boot.

17. The fiber optic connector according to claim 16, wherein the back portion has a ribbed structure with open-

12

ings on an outside surface along a length of the back portion to provide strain relief to a fiber cable containing the two optical fibers.

18. The fiber optic connector according to claim 16, wherein the boot is movable longitudinally relative to the housing upon application of a pull force, and wherein after application of the pull force, the boot and the housing are rotatable relative to each other to change a polarity of the fiber optic connector.

19. The fiber optic connector according to claim 16, wherein the front extension is an integrally molded with the center portion and has a latch.

20. A fiber optic connector comprising:

a boot;

a crimp body engaged to the boot forward of the boot; and
a housing having two optical fibers terminated respectively within two fiber optic ferrules therein, the housing comprising a front end opening for the two fiber optic ferrules, a pair of short sides forming a top and a bottom and a pair of long sides joining the top and the bottom, a separation between the top and the bottom is more than a separation between individual ones of the pair of long sides, the two fiber optic ferrules being spaced apart from each other between the top and the bottom but equidistant from each of the pair of long sides,

wherein the crimp body is positioned rearward of the front end of the housing, the crimp body having a rear portion to receive the two optical fibers,

wherein the boot includes:

a center portion having a front end and a back end, a first longitudinal opening extending between the front end and the back end to receive a portion of the crimp body and a fiber optic cable having the two optical fibers,

a back portion attached to the center portion and extending away from the front end of the center portion, the back portion defining a second longitudinal opening that is in communication with the first longitudinal opening, and

a front extension portion connected to the center portion and extending forward and beyond the front end of the center portion, and

wherein the boot is movable longitudinally relative to the housing upon application of a pull force, and wherein after application of the pull force, the boot and the housing are rotatable relative to each other to change a polarity of the fiber optic connector.

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